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REPORT:

National report of Norway 2019: The Norwegian Tide Gauge Network

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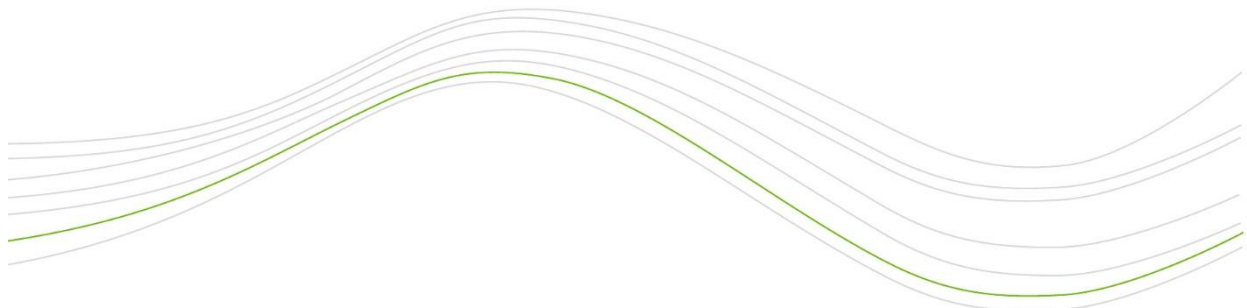
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The tide gauge network

The Norwegian Mapping Authority, Hydrographic Service (NHS) operates the Norwegian tide gauge network. There are 23 tide gauges along the Norwegian coast, one gauge in Ny-Ålesund at Svalbard, see Figure 1 and Table 1. The tide gauge at Jan-Mayen has been out of service since 2016.



Figure 1: The Norwegian tide gauge network, March 2019

Station	Latitude	Longitude	Continuous GNSS	Data available from
Viker	59°02' N	10°57' E	No	1990
Oslo	59°54' N	10°44' E	No	1914
Oscarsborg	59°41' N	10°37' E	No	1953
Helgeroa	59°00' N	09°52' E	No	1965
Tregde	58°00' N	07°34' E	Yes, since 2001	1927
Stavanger	58°58' N	05°44' E	No	1919
Bergen	60°24' N	05°18' E	Yes, since 2019	1915
Måløy	61°56' N	05°07' E	No	1943
Ålesund	62°28' N	06°09' E	No	1961
Kristiansund	63°07' N	07°45' E	No	1952
Heimsjø	63°26' N	09°07' E	No	1928
Mausundvær	63°52' N	08°40' E	Yes, since 2007	1988
Trondheim	63°26' N	10°24' E	No	1989
Rørvik	64°52' N	11°15' E	No	1969
Bodø ³	67°18' N	14°24' E	No	1949
Kabelvåg	68°13' N	14°30' E	No	1988
Narvik	68°26' N	17°25' E	No	1931
Harstad	68°48' N	16°33' E	No	1952
Andenes	69°19' N	16°09' E	Yes, since 2000	1991
Tromsø	69°39' N	18°58' E	No	1952
Hammerfest	70°40' N	23°41' E	No	1957
Honningsvåg	70°59' N	25°59' E	Yes, since 2006	1970
Vardø	70°20' N	31°06' E	Yes, since 2005	1947
Ny-Ålesund	78°56' N	11°57' E	Yes, since 1993	1976

³ The tide gauge in Bodø was moved to a new location in February 2016

Station	Latitude	Longitude	Continuous GNSS	Data available from
Jan-Mayen (out of service since August 2016)	70°55' N	08°43' E	Yes, since 2007	2014

Table 1 : List of stations in the Norwegian tide gauge network

All the permanent tide gauges are of the stilling well type, except in Hammerfest where a radar gauge (Miros SM-094) is used (since August 2007) and at Jan-Mayen where a pressure gauge has been used.

The sampling frequency is 1 Hz and one-minute averages are stored in the data logger, transferred to NHS at regular intervals (every 20 minutes) and stored in a database. The one-minute values are quality controlled using an automatic routine. If the data pass the quality control successfully, they are filtered (Butterworth filter) and decimated to produce ten-minute values. The ten-minute values are presented on the internet in near real-time. If the data do not pass the automatic quality control, a manual control is required. Software developed in-house is used for data control, processing and analysis.

In August 2014, a permanent tide gauge was successfully installed on the island of Jan Mayen, located midway between Norway and Greenland. Unfortunately, the tide gauge was damaged by the rough weather in 2016 and is currently out of order. There is approximately 2 years of data from this tide gauge but the reference levels are still uncertain. The installation of a new tide gauge is planned but the time frame for this is uncertain. Because of the remote location and rough weather, the installation and the technology used has to be considered carefully.

In February 2016 the tide gauge in Bodø was moved to a new location nearby the old tide gauge. Existing data series have been transferred to the new tide gauge position.

The majority of the gauges are mounted on solid rock and are levelled with about three years intervals. The Norwegian Mapping Authority, Geodetic Institute is responsible for the levelling.

Temporary tide gauge network

In addition to the permanent tide gauge network the NHS also operate a network of temporary tide gauges. This network consists of shorter time series spanning from a couple of days to a few years. The data are used for bathymetric surveying, in relation to work done by the coastal administration and to improve NHS' knowledge of the water level variations along the coast.

GNSS measurements

By March 2019, ten continuous GNSS receivers (CGPS) are installed at nine Norwegian tide gauges. In Vardø, Andenes and Tregde the antennas are installed directly at the tide gauge, on the other stations the GNSS receivers are some

hundred meters away. In Ny-Ålesund the GNSS receivers are installed near the VLBI-station (Very Long Baseline Interferometry), which is located about 1.5 km from the tide gauge.

In November 2015, a new GNSS station was established in Måløy, about 800 meters from the tide gauge. The height of the GNSS antenna is measured by precise levelling.

In January 2019, a new GNSS station was established in Bergen, about 80 meters from the tide gauge. The height of the GNSS antenna is measured by precise levelling.

In April 2016, the GNSS receiver at Mausundvær was renewed.

In June 2017, the GNSS receiver at Andenes was renewed.

Station	Continuous GNSS from	GNSS receiver type	Serial nr.	Firmware version	Sampling rate	Antenna type	Ra-dome
Tregde TGDE	2001	Trimble NetR9	5128K7 6924	5.37	1 sec.	AOAD/ M_T	None
Andenes ANDE	2000	Trimble NetR9	5639R5 0183	5.37	1 sec.	Trimble Zephyr TRM55971. 00	None
Ny-Ålesund NYA1	1997	Trimble NetR8	4843K3 3429	48.01	1 sec.	ASH 701073.3	Snow
Ny-Ålesund NYAL	1993	Trimble NetRS	44392 39123	1.3-2	1 sec.	AOAD/M_B	Dome
Vardø VARD	2005	Trimble NetRS	44122 32898	1.3-2	1 sec.	Trimble TRM 29659.00	Dome SCIS
Mausund- vær FROC	2007	Trimble NetR9	5543R5 0154	5.37	1 sec.	Trimble Zephyr TRM55971. 00	None
Honnings- våg HONS	2006	Trimble NetR9	5351K4 8957	5.37	1 sec.	TRM59800. 00	Dome SCIS
Jan Mayen JANS	2007	Trimble NetR9	5349K4 8322	5.37	1 sec	TRM41249	None
Bergen BERH	2019	Leica GR50	183255 9	4.31	1 sec	LEIAR20	LEIM
Måløy MALO	2015	TRIMBLE NetR9	5450R5 0005	5.37	1 sec	TRM59900. 00	Dome SCIS

Table 2: An overview of the status of continuous GNSS receivers per March 2019

The Norwegian Mapping Authority, Geodetic Institute is responsible for the continuous GNSS measurements and analyses of the data.

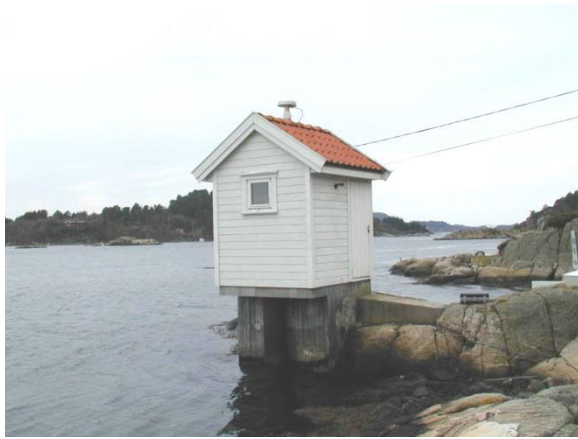


Figure 2: Tide gauges with continuous GNSS receivers at Tregde (to the left) and at Andenes (right)

Data availability

By the end of 2018, the Norwegian water level database contained water level data from more than 300 temporary tide gauges and 1473 years of water level observations from the permanent tide gauges. All data have been through a quality control, and all corrections are flagged and documented. Figure 3 gives an overview of the available digital time series from the permanent tide gauges in operation.

Station	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000	2010
Andenes									■	■	■
Bergen	■	■	■	■	■	■	■	■	■	■	■
Bodø									■	■	■
Hammerfest									■	■	■
Harstad									■	■	■
Heimsjø									■	■	■
Helgeroa									■	■	■
Honningsvåg									■	■	■
Jan-Mayen											■
Kabelvåg									■	■	■
Kristiansund									■	■	■
Mausund									■	■	■
Måløy									■	■	■
Narvik									■	■	■
Ny-Ålesund									■	■	■
Oscarsborg									■	■	■
Oslo	■	■	■	■	■	■	■	■	■	■	■
Rørvik									■	■	■
Stavanger	■	■	■	■	■	■	■	■	■	■	■
Tregde									■	■	■
Tromsø									■	■	■
Trondheim									■	■	■
Vardø									■	■	■
Viker									■	■	■
Ålesund									■	■	■

Available water level data
 Water level data available for download
 Continuous GNSS data



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Figure 3: An overview of available time series from the stations in the network

International data exchange

Quality controlled water level data are routinely made available through the following international programmes:

- PSMSL : Monthly and annual means
- GLOSS : Fast delivery data to UHSLC

Distribution of data and products

The following quality checked water level data is available for free download on our web site [Se havnivå](#), from all the permanent tide gauges except Mausundvær and Jan-Mayen:

- Water level observations (from around 1990 to now, see Figure 3 for details)
- Tidal predictions
- Residuals

- Water level prognosis for 5 days (based on a model from the Norwegian Meteorological Institute)
- Monthly and annual means (from start of measurements to now)
- Vertical datums (Tidal levels, reference levels, storm surge return levels)
- Projections of future sea level change in Norway

Most of these data are also available for almost all positions along the coast based on interpolation between tidal gauges.

The same data are also available through our [API](#) (Application programming interface), which makes it possible to integrate the water level data in external systems and applications.

The official Norwegian tide tables are only available through our web site, as a pdf-file.

In late 2018, the Norwegian Mapping Authority launched a new web service, [Se havnivå i kart](#) (Visualize sea level). This web tool visualize present-day storm surge levels and future sea level rise in a map viewer and illustrate the potential scale of inundation caused by sea level rise and storm surge. The map layers are available for download and can be used in custom GIS applications, for instance for coastal planning purposes.

All data and products available online are free of charge